
EPA's ORD Research Program on Alternative Technologies, Part II

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At North Carolina State University, we are principally working on the development of new and existing technologies that may prove to be viable alternatives to the use of perchloroethylene (perc) and other presently available systems. One of the things we're currently working on is ultra-sound cleaning. As most of you know, cleaning variables involve time, temperature, agitation, and chemistry. Ultra-sound may prove to be a substitute for mechanical agitation, water, perc, and hydrocarbon cleaning. It also may substitute, partially at least, for temperature. That is, we may be able to clean at a much lower temperature than we would without ultra-sound. We are looking at ultra-sound both for solvent-based and water-based systems. The ultra-sound for solvent-based cleaning will use perc and DF2000 systems as benchmarks. Just by looking at their properties from the literature and so forth, we have actually screened about 135 different solvents. I think we've used 11 or 12 to actually do some preliminary tests. We have done this as very rough testing. Later, we will use the successful preliminary experiments to do standard tests on fabrics and soils.

Preliminary results for ultra-sound solvent-based cleaning indicate that solvents that work on a soil in normal type drycleaning will work on the same soil much faster with the use of ultra-sound. And the opposite is also true—solvents that don't work on a soil are not going to be effective with ultra-sound. So, in essence, ultra-sound will enhance whatever a solvent's ability has to take off a soil to begin with. In using ultra-sound cleaning on a water-based system, our objective is to develop a greener cleaning system that removes complex soils and eliminates the use of non-aqueous solvents. This may prevent shrinkage in such fabrics as wool because it eliminates most of the

usual mechanical agitation that is one of the primary causes of shrinkage, rather than the water. So ultra-sound may give us a way to apply water-based cleaning without all of the agitation. We're finding that a temperature of 122° Fahrenheit gives good results. We get some very good cleaning from this. We have found that using ultra-sound and wet cleaning may give you hand problems, but that's probably due to the fact that we're not tumble drying the garments. We would probably need to find a way to dry them that would enhance the hand by giving some kind of substitute for agitation. As we find systems that work in both the water-based and solvent-based tests, we will use the standard samples and soils so that we will be able to compare all these types of cleaning. In the initial work, which has been going on for some time in ultra-sound, however, we have done very crude screening-type research because it would be too expensive to run all of the standard type soils and samples with this type of experimental apparatus.

In carbon dioxide (CO₂) cleaning, we will focus our research on liquid or subcritical technologies. Originally, we had thought in terms of supercritical carbon dioxide cleaning, but it turns out that supercritical CO₂ may damage buttons and zippers, while subcritical CO₂ seems to work well. When Charles Riggs [EPA's ORD Research Program on Alternative Textile Care Technologies, Part I] was talking about the supercritical or the liquid CO₂ work that they were doing, he was referring to a prototype commercial machine. We are in the process of building a benchtop experimental apparatus so we can get a very wide range of variables and look at the use of surfactants and examine the variables in liquid carbon dioxide cleaning. This will allow us to look at many more things than we could in a pro-

totype system and should tie in very well. Again, for the things we find successful in carbon dioxide cleaning, we will then run those experiments on standard samples, and so forth.

At North Carolina State University, we're using our testing lab to run most of the tests on the samples that Charles Riggs produces as well as those that we produce, so that we can compare them all in one place. As much as possible, we're trying to use American Society for Testing and Materials American Association of Textile Chemists and Colorists type standards so that we will be able to compare with the work that other people do and not have to generate or produce entirely new test methods, although some of that may be necessary.

I have a lot more details on what we're planning to do and even some of the preliminary results. I'll be

happy to discuss those now or in the discussion session. I want to reemphasize what Charles Riggs has said, that this project is just getting underway. Most of the work will be done in the coming months. It was proposed and accepted as a 3-year project, but we've only been funded for 1 year. Our results obviously will depend on whether we're able to secure second and third year funding for this work. What we've laid out is primarily for 3 years, but we've tried to adjust the project so that if funding does not come forward for the second and third year we will still produce some useful results even in the first year. We have formed an advisory committee for this project and the first meeting will be Wednesday, September 12, 1996, in Raleigh. We think this is an excellent forum and we would welcome any input you have into the design and direction of this project.

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Testing And Development of Pollution Prevention Alternatives to Reduce Indoor Air Emissions from Perchloroethylene Dry Cleaning and Dry Cleaned Fabrics

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Ultrasound Cleaning

- **Cleaning Involves**
 - Time
 - Temperature
 - Agitation
 - Chemistry
- **US May Substitute for**
 - Mechanical Agitation in Water PCE & Hydrocarbon Cleaning
 - Temperature

3

Ultrasound Cleaning

- **Solvent Based**
 - **Benchmarks**
 - PCE
 - DF-2000
 - **135 Screened, 11 Used**
- **Preliminary Results**
 - **Solvents That Work on a Soil Will Work Faster With US**
 - **Solvents That Don't Work on a Soil Are Not Effective With US**

4

Ultrasound Cleaning

- **Water Based**
 - **Objective:**
 - **Develop a "Greener" Cleaning System That removes Complex Soils and Eliminates Use of Non-Aqueous Solvents**
 - **May Not Cause Shrinkage**
 - **Eliminates Most Mechanical Agitation**
- **Preliminary Results**
 - **122 Degrees F Gives Reasonable Results**
- **Standard Samples & Soils Will Be Tested**

Carbon Dioxide Cleaning

- **Focus on Liquid (Subcritical)**
 - **Supercritical May Damage Buttons and Zippers**
- **Bench Top Experimental Apparatus**
- **Wide Range of Variables**

